PLATEAU PIKA CONTROL IN SANTU ALPINE GRASSLAND COMMUNITY, YUSHU PREFECTURE, QINGHAI PROVINCE, CHINA

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ABSTRACT

Chemical control of the Plateau Pika (*Ochotona curzoniae*) is practiced on the Tibetan Plateau as the result of policy-makers labeling the species a pest that competes for forage with livestock and accelerates grassland degradation. Conversely, pikas are believed by others to be an ecological keystone species.

Research from September to November 2007 in Santu Pastoral Community, Jiqu Township, Nangqian County, Yushu Tibetan Autonomous Prefecture, Qinghai Province, PR China examined differences in biodiversity of grassland between two selected areas to determine how chemical control impacts vegetation and predator populations, and relationships between pikas, grassland degradation, and livestock grazing.

Results suggest predators rely on pikas for survival and that pikas contribute to degradation of the grassland ecosystem, particularly when population density is high. Sustainable grassland management taking into account livestock grazing sustainability and biodiversity conservation is recommended. Pika control is required and should be based on protection of pika predators.

KEY WORDS

chemical control, keystone species, pika, Tibetan Plateau

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BACKGROUND

Plateau Pika are important food for raptors and mammalian predators. Their burrows are primary homes and nests for a wide variety of birds and lizards. They also help increase vegetative species diversity and variety by creating microhabitat disturbance, and contribute to soil nutrient recycling and enhanced root biomass (Smith and Foggin 1999). With such multiple ecological roles, Plateau Pika are considered a keystone species on the rangeland ecosystem of the Tibetan Plateau (Smith and Foggin 1999).

Raptors that live in or pass through the alpine grassland ecosystem of the Tibetan Plateau include the Steppe Eagle (*Aquila nipalensis*), Upland Buzzard (*Buteo hemilasius*), Saker Falcon (*Falco cherrug*), Goshawk (*Accipiter gentilis*), Black Kite (*Milvus migrans*), Little Owl (*Athene noctua*), and Big Owl (*Bubo bubo*) (Lai and Smith 2003). These large predatory birds depend on pikas as a food source. Schaller (1998) reported that 90% of pellets under the nest of a Saker Falcon and all pellets beneath the nest of an Upland Buzzard contained pika remains. A similar species, the Daurian Pika (*Ochotona dauurica*) in Inner Mongolia Autonomous Region, China, also comprises large percentages of the diet of avian predators: Steppe Eagle (62%), Upland Buzzard (17%), Eagle Owl (73%), and Saker Falcon (22%) (Peshkov 1957, 1967).

The pika's role in pasture degradation is much debated. The Chinese government has labeled pikas as pests that contribute to grassland degradation and has launched repeated programs to eliminate the species with poisons. An unfortunate consequence of these campaigns is the death of other species (Smith 1998).

Elimination of pikas would disrupt prey-predator relationships and lead to reduction in predator populations. Furthermore, lessons from such control measures over the past decades suggest poisons are ineffective. A comprehensive approach to improve the overall quality of the grassland ecosystem is an important solution. Ninety to 95% reductions in

pika populations have been achieved using poisons, resulting in an abrupt reduction in the food supply for many predators for one to two years. However, pikas recovered rapidly over the following breeding seasons (Pech et al. 2007), and caused further damage to the grassland ecosystem. If pika control is required, this study suggests rodenticides are ineffective over the long term.

THE PROBLEM

Control attempts were undertaken in many parts of the Plateau because pikas were seen as putatively competing with livestock for forage and were found at high density (Liu et al. 1980; Shen and Chen 1984; Smith et al. 1990). Pikas thrive on degraded grassland ecosystems where there is less and shorter vegetation (Smith et al. 1990). Consequently, the high density of pika populations repeatedly drew the attention of government and subsequent control measures.

STUDY OBJECTIVES

This study aims to:

- characterize pikas as pests or a keystone species on the alpine grassland ecosystem of Santu Pastoral Community;
- investigate environmental impacts of chemical control of pikas on pika predators and other biodiversity components of the alpine grassland ecosystem; and
- recommend strategies to sustainably manage pika populations.

SIGNIFICANCE OF THE STUDY

Pikas play an important ecological role as a keystone species (Smith and Foggin 1999, Lai and Smith 2003) and contribute to grassland degradation. Consequently, there is need for continuing research on pikas to suggest or reject initial findings related to management strategies.

RESEARCH SETTING

This research was conducted on two different study sites in the pastures of two herding groups within Santu Pastoral Community (Jiqu Township), 150 kilometers from Nangqian County Town, from September to November 2007.

Based on data from the Meteorology Bureau of the local county government and the provincial government, the average elevation of Jiqu Township is 3,500 meters above sea level and is characterized by undulating mountain ranges with consistent intermountain grassland valleys. The major vegetation type is alpine meadow. The continental monsoon climate is dominated by the southeast monsoon and high pressure from Siberia. Temperatures range from -37.1°C to 27.6°C, with the average being -1.7°C (QNXQ). Cold weather lasts five to six months. Summer is short and cool. Other seasons are transitional periods for summer and winter. The average annual precipitation is 426-860 millimeters, 80% of which falls in the short summer. Annual average sunlight is 2,462.7 hours with 60% of total available sunshine (QNXQ).

Research sites A and B are contiguous pastures, share a similar biome typical of alpine grassland biological diversity, and share indistinguishable regional climatic, ecological, and climatic characteristics. The area is dominated by grass species supporting the livelihood of thirty-one households (Site A) and twenty-seven households (Site B). The total community population is approximately 350 people, whose basis for subsistence was 7,000-8,000 head of livestock.

Control programs were implemented multiple times to eliminate Plateau Pikas on Site A, whereas pika control had never been attempted on Site B. Quantitative data from the two sites were analyzed and compared as indicators of grassland degradation.

RESULTS

Data Analysis of Vegetative Species Sampling

Data on grass species density were collected by establishing quadrats at both sites. During sampling, all grass species within each of seventeen plots was counted on both sites and the density of each grass species that were encountered was determined by dividing the total number of each grass species in the seventeen plots by the total sampled area to better understand the grass species' relationship with pikas and the impact of elimination of pikas with chemical control.

Local respondents named twenty plant species during interviews on both sites. However, during sampling, only five grass species were common on both sites, out of around fifteen identified grass species. Grass density was higher on Site B than on Site A. The four major grass species were the same for both sites and were regarded as major forage for domestic livestock and wild herbivores. These major species comprise 80-90% of the total coverage of vegetative species within the two study sites. Distribution of other grass species in both sites was random.

Overall density of grass species was much higher on Site B than on Site A. Density of *bdag rtswa* on Site B was almost twice (A = 71.4: B = 122.2) that of Site A. Density of *ljang rtswa* was twice (A= 23.6: B = 55.9) as high on Site B than on Site A. Density of *khab 'dra rtswa* was nearly twice (A = 13.6; B = 23.9) as high on Site B than on Site A.

Livestock Population on the Two Study Sites

Livestock population on both sites was similar. Estimates by local informants were 4,500 sheep, goats, and horses for Site A, and 3,800 for Site B. The number of households on Site A was higher than on Site B. The size of the grazing territory was based on livestock number and human population.

Herders' Views on Pikas and Grassland Degredation

Survey interviews were conducted with locals who had observed the grassland ecosystem in their everyday lives for decades. Much of their knowledge about the grassland ecosystem, such as the interdependent relationships inherent to biodiversity, including their livestock, had been passed down from generation to generation through actual practice. Interviewees identified predators and plant species, abundance and frequency of predators, and dominant grass species on both sites. These data were gathered to compare the data collected from sampling.

Thirty informants from both sites were selected to determine vegetative species identification and dominance. The respondents were asked to decide the dominant grass species from the grasses that were identified on both sites. Thirteen species of grasses were identified by interviews on Site A and fourteen species of grasses were identified on Site B. The species of grasses identified were different on sites A and B, as were their frequency.

Informants' opinions varied on other grass species observed in these areas in relation to livestock and such wildlife as plateau pikas. Based on local residents' observation and accumulated knowledge on grassland biodiversity, domestic livestock and pikas consumed the same vegetative species. There were exceptions – livestock grazed certain grass species that pikas did not and vice versa. Both livestock and pikas, however, grazed the dominant grass species, which formed the largest parts of their diet.

Interviews on grassland health and pika population before poisoning were conducted. Local herders' views varied on the

causes of rangeland degradation and on the time that grassland degradation occurred. Eight out of ten respondents from Site A stated that pikas on the pasture were never an issue until formation of the commune system in the 1960s. The first pika control measure was implemented in the 1970s on Site A after the scientific community declared pikas damaged the pasture. Two other respondents in Site A stressed that pikas were the most serious cause of grassland degradation. However, both respondents (b. 1949, 1946) did not remember specific instances when pikas were directly linked to grassland damage during the commune system period.

All ten respondents on Site A stated that the number of pikas continually increased after formation of the commune system and respondents believed that grassland condition had deteriorated during that time, as seen in a decrease in grass height, decrease of grass coverage, and expansion of bare land. Simultaneously, degradation of the grassland ecosystem was followed by an increase in the pika population with the pika population expanding over huge areas.

Similarly, ten herders from Site B were interviewed and all claimed to have witnessed the emergence and increasing population of pikas within the area in the past two decades. They all considered the pika damaging to the grassland ecosystem in the 1990s, although sparse populations of the species existed earlier. They agreed that pika population density had increased. Many respondents could not attribute the causes of grassland degradation, but claimed the pasture in their area was worsening as evidenced by a decrease of vegetative coverage, emergence of more bare land, and deterioration of livestock health and productivity.

Locals believed that the high pika population density had damaged the grassland by burrowing and digging, which they believed transformed turf into black sand. The locals described the consumption habits of plateau pikas as similar to locals cutting grass for winter fodder, extracting plants from the roots up, and eventually destroying the plant coverage on which domestic livestock grazed. Locals were unconcerned with the viability of grassland for livestock grazing before the 1990s.

Thus, the grassland crisis on Site B seemed to have started after the 1990s.

Pika Predator Frequency

Data on frequency were determined by interviewing respondents on their observation of the occurrence of raptors and mammal predators during summer and autumn.

Figure 1 presents perceived frequency of pika predators. The numbers indicate responses of 'often', 'sometimes', 'seldom', and 'never'. Interviews regarding predator identification suggested predator diversity was the same. However, statistical analysis of the data showed that predator number was lower on Site A, where chemical control efforts had been executed consistently from 2002-2006. The mean frequency of predatory species on Site A was classified as 'sometimes'. For Site B, more respondents classified frequency of predators as 'often', indicating the highest frequency observed for local predators. The observed frequency rate of predators on Site B was higher than on Site A.

Figure 1. Reported predator frequency on sites A and B.

Species	Often		Sometimes		Seldom		Never	
	A	B	A	B	A	B	A	B
Big Owl	10	9	13	14	7	7	0	0
Upland Buzzard	6	27	20	3	4	0	0	0
Raven	9	9	14	16	7	5	0	0
Steppe Eagle	8	24	21	6	0	0	0	0
Black Eared Kite	9	21	19	7	2	2	0	0
Saker Falcon	5	29	22	1	3	0	0	0
Little Owl	12	14	16	9	2	6	0	0
Tibetan Sand Fox	14	25	15	4	1	1	0	0
Tibetan Fox	4	28	22	1	4	1	0	0
Tibetan Wolf	6	18	20	11	4	1	0	0
Weasel	13	22	14	6	3	0	0	0
Brown Bear	2	6	21	19	7	5	0	0
Wild Cat	5	11	19	13	6	5	0	1
Wild Dog	7	13	21	10	0	2		0
Snow Leopard	0	0	3	5	19	12	6	12

Data on the abundance of raptors and other predators of pikas were obtained from thirty selected respondents at each site. Abundance of each predator was classified as 'many', 'few', and 'zero'. The numbers of predators that respondents reported to have observed during the summer and autumn of 2007 on their pastures were represented using the three measurement standards.

Figure 2 shows significant differences in the abundance of pika predators between the two sites. The average abundance, however, was classified as 'few' in Site A, in an area where the pika population had been extensively controlled in the past four years. The latest stabilization program in Autumn 2006 indicated that 90-95% of the population in the area had been reduced as a direct result of poisoning (AHBNC data). Conversely, abundance of pika predators, including raptors and mammal predators, was classified as 'many' for Site B, where control methods were never implemented. Results suggested there were more pika predators in the non-controlled site than on the controlled site.

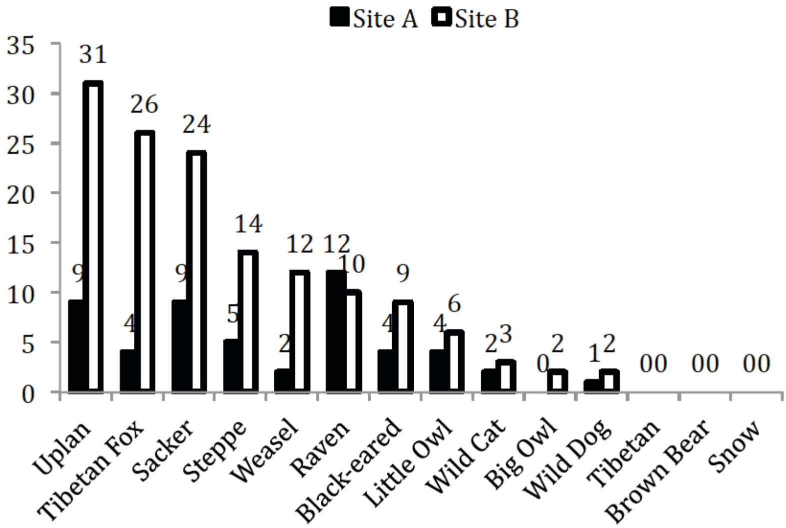
Figure 2. Reported predator abundance on sites A and B.

	Species Abundance on Site A			Species Abundance on Site B		
Species	Many	Few	Zero	Many	Few	Zero
Big Owl	12	15	3	8	21	1
Upland Buzzard	6	22	3	30	0	0
Raven	10	17	3	10	18	2
Steppe Eagle	8	20	2	24	6	0
Black Eared Kite	10	18	2	23	7	0
Saker Falcon	8	20	2	30	0	0
Little Owl	15	14	1	15	12	3
Tibetan Sand Fox	18	11	1	26	4	0
Tibetan Fox	7	21	2	29	1	0
Tibetan Wolf	6	23	1	17	6	7
Weasel	18	11	1	27	2	0
Brown Bear	2	22	6	8	15	7
Wild Cat	8	18	4	17	11	3
Wild Dog	9	17	4	14	15	0
Snow Leopard	0	12	0	3	5	22

Sampling of predators related to pikas was done by counting observed predators within three days of transect walks at both sites. All sighted predators were counted and noted as shown in Figure 3 below.

No wolves, brown bears, or snow leopards were observed. Results show a significant difference in the number of predators on the two sites. Local nomads argued that the Upland Buzzard, Tibetan Fox, Saker Falcon, and Weasel (*Mustela nivalis*) were key predators. This was supported by my data.

Figure 3. Predatory animal population on sites A and B.



Sightings of the five prominent predators were more frequent in the non-controlled area (Site B) than in the controlled area (Site A). There were about three times as many upland buzzards on Site B as on Site A (Site A = 9; site B = 31); two times as many Saker falcons on Site B as on Site A (Site A = 9; Site B = 24); four Tibetan Foxes were observed on Site A while twenty were sighted on site B (Site A = 4; Site B = 26); and three times as many steppe eagles were sighted on Site B as on Site A (A = 5; B = 14). Locals said weasels were a major pika predator, which matched my findings of two weasels on Site A and twelve on Site B (Site A =2; Site B = 12).

Raptors may be classified into two categories based on prey habits and habitat preference. Nocturnal raptors prey at night and include Big Owl and Little Owl. The others prey during the day. While gathering data, two Big Owl were identified on Site B based on sounds heard twice for two nights. No sound of the same raptor was heard on Site A, although two Big Owl were seen. Likewise, two Little Owl were sighted on Site A, while six of the same species were identified on Site B.

Although Brown Bear (*Ursus arctos*), Wolves (*Canis lupus*), and Snow Leopards (*Uncia uncia*) are considered important pika predators by both local nomads and researchers, none were sighted during sampling. This may be attributed to observations being conducted in late summer; abundance varies significantly with season. These predators were usually seen on high mountains and areas with little human presence.

Raptors were more abundant than mammalian predators on both sites (forty-one raptors and eight mammals on Site A, ninety-six raptors and fifty mammals on Site B). During sampling, interactions between raptors and pikas were higher than between mammal predators and pikas.

Locals report that raptors that prey on pikas also prey on Hume's Groundpecker (*Pseudopodoces humilis*) and Snowfinch (*Montifringilla spp.*) that inhabit burrows created by pikas. During sampling, it was observed that small bird species, especially those that sheltered in burrows created by pikas, were more abundant than the pikas themselves. This phenomenon was distinctively apparent on Site B where there were large pika populations. More small birds were sighted on Site B than on Site A.

Pika Burrows

The pika population was estimated by counting the number of active burrows within the measured plots on each site. Twenty-one active burrows were observed on Site A, which was considered the average number of active burrows within the three

hectares of total sampled area. A limited number of pikas were sighted while sampling Site A. Fresh burrows were only observed in the lower areas of the sampling site, characterized by small hills and level areas. Signs of pika presence were infrequently observed on the higher areas of Site A. Collapsed and inactive burrows were observed on Site A, where pika population was high before control. The most recent control measure was in March 2006. Local informants explained that control measures were implemented on an irregular basis.

Pikas abandoned areas where their burrows were so dense that there was no longer adequate burrowing space and moved to areas with sufficient grass and space. The whole survey area had many burrows, causing soil erosion on severely infested areas.

Sampling for active burrows was conducted on both sites to assess the pika population. Active burrows were counted on three hectares of land on Site B and 487 active burrows were found. Almost all had newly dug soil and fresh traces of pika activities. Unlike Site A, no control measures had been implemented on Site B. Based on observations and interpretations by local nomads, pikas increased significantly beginning in the 1990s, and became a major problem in succeeding years. The presence of densely scattered burrows indicated that the pikas were damaging the grassland ecosystem, particularly vegetation, through soil erosion.

Further information on pika population status prior to 2006 was gathered from the Nangqian County Animal Husbandry Bureau, which showed that the total infected area of the grassland ecosystem of Nangqian County was about fifty-nine million hectares, representing 53.19% of usable rangeland. In Santu Pastoral Community, 47% of the rangeland was infested with pikas. According to an investigation by the Qinghai Bureau of Animal Husbandry, there were 1,928 burrows per hectare of land in pika-infested areas of Nangqian County. Site A featured 637 observed burrows. Compared to other infested areas, this indicated reduced population density, attributed to control measures in 2006 aiming to reduce the 637 active burrows to less than eight within one hectare of pasture and to increase grass

coverage from 25-40%. No previous investigation on pika population density had been done on site B.

DISCUSSION

Interviews with local nomads suggested that the frequency and abundance of predators on the two sites were significantly different – there were more predators on site B with a large pika population. The data indicated fewer pika predators on Site A where the pika population density was dramatically reduced in 2006.

According to Site A respondents, the frequency and abundance of predators within the autumn and summer of 2006 had dropped significantly. They claimed that there was more wildlife, particularly raptors, in the previous years when there were more pikas (prior to the most recent pika eradication program in 2006). Meanwhile respondents did not notice any change in the abundance and frequency of predators from 2006-2007. Most respondents cited 'many' to describe the number of predators based on observations during the summer and autumn of 2007, and 'often' on predator frequency. Interview data suggested nearly the opposite for abundance and frequency of raptors on Site A. It is thus likely that control measures aimed at eliminating pikas compromised the ecological niches of non-target species, causing critical disturbance to the prey and predator relationship.

Predators such as the Upland Buzzard, Saker Falcon, Steppe Eagle, Blackeared Kite, Tibetan Fox, and Weasel were considered the most important predators and were rarely sighted on Site A, but were abundant on Site B. It can be assumed that pikas played an irreplaceable role in the food chain. Most predators on the Tibetan Plateau are dependent on pikas as their major food source (Schaller 1998; Smith et al. 1990), especially during winter when most prey hibernate. Pikas were almost the only winter food source for predators (Smith and Foggin 1996).

Pikas provide an indispensable service maintaining the grassland ecosystem. During the sampling period, some varieties of small birds were sighted in places where pikas existed. According to local nomads, such small birds as Hume's Ground Jay and Snowfinch are interdependent on Plateau Pika for survival on the grassland ecosystem. These birds act as safeguards for the Plateau Pika, signaling when predators approach. This occurred during sampling between weasels and pikas. A flock of small birds circled the weasels while chirping, signaling the pikas of approaching danger. Meanwhile, these birds live in burrows made by pikas, and such activities as food collection occurs in areas around the burrows, which are also bird breeding habitat. Hume's Ground Jay, several species of snowfinch, and native lizards (*Phrynocephalus spp., Eremias spp.*) breed and nest in pika burrows (Smith and Foggin 1996, 2002). Thus, pikas likely determine the conservation of these species while acting as an important mechanism for the survival of species heavily dependent on them.

Snow leopards, brown bears, and wolves were not sighted while sampling. Local nomads affirmed that pikas are important food for those species, especially in recent years when blue sheep, deer, and gazelles, are greatly reduced in number. Wolves, snow leopards, and brown bears prey on pikas (Smith and Foggin 1996), which can provide a major proportion of their food. The Steppe Eagle, Upland Buzzard, Saker Falcon, Goshawk, Black Kite, and Little Owl (Schaller 1998; Smith and Foggin 2000) remain major pika predators.

Raptors on Site B were more significantly and frequently observed than on Site A during sampling. Statistical data indicates that predator abundance on Site A was strikingly less than on Site B, suggesting a relationship between predator number and pikas. Fewer predators were found where there were fewer pikas.

The important ecological role of pikas in the food chain of the grassland ecosystem is a decisive mechanism for conservation of predators. Pika population density largely determines the abundance of most raptors and mammal predators. Control

measures designed to eliminate pikas have significant negative impacts on the conservation and survival of predators, small birds, and lizards, causing deterioration of the grassland ecosystem.

According to local herders, pikas eat all varieties of grass species, causing an obvious reduction in grass density within a few years in an area. Data from the Nangqian County Animal Husbandry Bureau suggest that one mature pika consumes about 77.3 grams of forage daily or about 9.5 kilograms of grass during growing season. Consequently, fifty-two pikas consume the same forage per day as one Tibetan Sheep (*Ovis aries*).

Data shows a large difference in vegetative species density between the two sites. Dominant grass species were denser on Site B where there were many pikas.

Data on grass species density on Site A shows that comparable dominant grass species were fewer than on Site B. Based on secondary data and locals' interpretations, the grassland ecosystem of Site A was severely degraded, the causes of which can be traced most prominently to pika infestation. The primary cause of degradation is most likely livestock overgrazing and such pika activities as burrowing and vegetation consumption (Swift et al. 2005), which were considered to significantly contribute to degradation. However, no concrete data supported these claims. Increases in pika population density should be interpreted as an indicator of grassland degradation rather than simply a cause. The population density of pikas appears to increase following grassland degradation because they are more capable of breeding and surviving on short grass. Local herders observed that pikas were more capable of proliferating on short grass where they easily detect approaching predators, and avoid capture. Tall grass areas are not pika-preferred habitat. A key informant witnessed predation more often in short grass areas than on tall grassy and fenced areas. He said that pikas cannot detect attack from Tibetan Fox in fenced areas because grass blocks their views.

Based on the numbers of sampled active burrows, there were more pikas on Site B than on Site A, though grass was

denser on Site B than on Site A; specifically dominant grass species were more abundant, which rejects the previous assumption, stating that pikas are a major factor causing grassland degradation. Nevertheless, the time length for pika occupation of each site is not taken into consideration for this justification. Moreover, there were no significant differences in the number of livestock on the two sites. The number of active burrows used as indicators of population density on Site B was thirty times more than on Site A. Likewise, the occurrence duration of pika infestation on Site A began two to three decades earlier than on Site B. The number of fresh pika burrows on Site A before the most recent control program was about twice that of current fresh burrows on Site B. Moreover, the grassland condition of Site B was believed to be worsening in tandem with the increasing pika population in recent years. Thus, pikas were evidentially contributing to grassland degradation when population density reached a significant level, and the time of infestation was significant for a given area.

RECOMMENDATIONS

This study has shown that pikas are ecologically vital species for the conservation of raptors and mammal predators, as well as small bird species and lizards on the Tibetan Plateau. Pikas contribute to improving plant growth. However, pikas negatively affect pasture when population density is high. Thus, utilizing artificial nests to increase raptor numbers is a recommended solution.

CONCLUSION

Grassland degradation is an on-going process on the Tibetan Plateau. Overgrazing by livestock is a major factor contributing to this growing problem. Government-led pika-elimination programs using chemical toxins have proven to be unsuccessful

in reducing the population permanently, while causing significant reduction in raptor and mammalian predators, rendering it a poor management strategy.

It is essential to reduce the pika population when it reaches high levels. Local nomads in most heavily infested areas claimed that the pika population increased in the recent past, a symptom of grassland degradation from livestock overgrazing and such factors as climate change.

Livestock overgrazing is a major problem over large areas. Research has determined that the number of livestock on the Tibetan Plateau has more than doubled in the past fifty years, with simultaneous decrease in productivity and livestock weight. Meanwhile, the pika population has increased within the last few decades, in tandem with the on-going process of grassland degradation (Arthur et al 2007).

Prevention of damage is easier than restoration. Significant reduction in livestock grazing pressure is a sustainable management strategy. Meanwhile, pika populations are required for the conservation of raptors, mammal predators, and other interdependent elements of grassland biodiversity. At the same time, pika control is required to allow grassland recovery to a degree that will not promote further pika population increases. Biological control methods should be implemented for more sustainable management of Plateau rangelands.